Another issue is bit errors induced by the digital channel; if they occur (and they will), synchronization can easily be lost even if the receiver started "in synch" with the source. Despite the small probabilities of error ofered by good signal set design and the matched filter, an infrequent error can devastate the ability to translate a bitstream into a symbolic signal. We need ways of reducing reception errors **without** demanding that p_e be smaller.

Example 6.4

The first electrical communications system the telegraph was digital. When first deployed in 1844, it communicated text over wireline connections using a binary code the Morse code to represent individual letters. To send a message from one place to another, telegraph operators would tap the message using a telegraph key to another operator, who would relay the message on to the next operator, presumably getting the message closer to its destination. In short, the telegraph relied on a **network** not unlike the basics of modern computer networks. To say it presaged modern communications would be an understatement. It was also far ahead of some needed technologies, namely the Source Coding Theorem. The Morse code, shown in Figure 6.19, was not a prefix code. To separate codes for each letter, Morse code required that a space a pause be inserted between each letter. In information theory, that space counts as another code letter, which means that the Morse code encoded text with a three-letter source code: dots, dashes and space. The resulting source code is not within a bit of entropy, and is grossly inefficient (about 25%). Figure 6.19 shows a Huffman code for English text, which as we know is efficient.